US008119011B1

(12) United States Patent

Nyman et al.

(10) Patent No.: US 8,119,011 B1
(45) Date of Patent: Feb. 21, 2012

(54) OPTIMIZED ALUMINA COAGULANTS FOR WATER TREATMENT

(75) Inventors: **May D. Nyman**, Albuquerque, NM (US); **Thomas A. Stewart**, Albuquerque, NM (US)

(73) Assignee: **Sandia Corporation**, Albuquerque, NM (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 540 days.

(21) Appl. No.: **12/369,042**

(22) Filed: **Feb. 11, 2009**

(51) **Int. Cl.**
C02F 1/52 (2006.01)
C02F 1/56 (2006.01)

(52) **U.S. Cl.** **210/725**; 210/716; 210/723; 210/724; 210/727; 210/737; 252/175

(58) **Field of Classification Search** 210/716
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,566,986	A *	1/1986	Waldmann	252/175
4,981,675	A *	1/1991	Haase et al.	423/556
5,246,686	A *	9/1993	Cuer et al.	423/467
6,036,935	A *	3/2000	Dulko	423/462
6,174,445	B1 *	1/2001	Reilly et al.	210/716

OTHER PUBLICATIONS

Ezwald, J K, "Coagulation in Drinking-Water Treatment-Particles, Organics and Coagulants", vol. 2711, 1993, pp. 21-35.

Yan, Mingquan, et al, Enhanced Coagulation for High Alkalinity and Micro-Polluted Water: The Third Way through Coagulant Optimization, Water Research 42 (2008) 2278-2286.

Bradley, Susan M., et al, Characterization of the $GaO_4Al_{12}(OH)_{24}(H_20)_{12}^{7+}$ Polyoxocation by MAS NMR and Infrared Spectroscopies and Powder X-ray Diffraction, Inorg. Chem. 1992, 31, 1181-1185.

Bradley, Susan M., et al, "The Structure of Al Gels Formed through the Base Hydrolysis of Al3+ Aqueous Solutions", Journal of Colloid and Interface Science 159, 405-412, (1993).

* cited by examiner

Primary Examiner — Peter A Hruskoci
(74) *Attorney, Agent, or Firm* — Daniel J. Jenkins

(57) **ABSTRACT**

Substitution of a single Ga-atom or single Ge-atom ($GaAl_{12}$ and $GeAl_{12}$ respectively) into the center of an aluminum Keggin polycation (Al_{13}) produces an optimal water-treatment product for neutralization and coagulation of anionic contaminants in water. $GaAl_{12}$ consistently shows ~1 order of magnitude increase in pathogen reduction, compared to Al_{13}. At a concentration of 2 ppm, $GaAl_{12}$ performs equivalently to 40 ppm alum, removing ~90% of the dissolved organic material. The substituted $GaAl_{12}$ product also offers extended shelf-life and consistent performance. We also synthesized a related polyaluminum chloride compound made of pre-hydrolyzed dissolved alumina clusters of $[GaO_4Al_{12}(OH)_{24}(H_2O)_{12}]^{7+}$.

19 Claims, 5 Drawing Sheets